Toward a Substantive Theory of Feature Specification

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1. Introduction.

The question addressed in this paper is a simple one: how much redundant information is present at the level of underlying representation? There have been many proposed answers to this question, but still little agreement on what the best answer is, or even on what criteria we should use to decide it. Part of the problem lies in the fact that it is unclear where the burden of proof lies. Is it legitimate to assume that underlying representations are redundancy-free unless we can persuasively argue to the contrary? Or can we make a case for the opposite position, that underlying representations are maximally specified unless we have good reason to believe the opposite? Our usual criteria fail us. For example, simplicity can be invoked in defense of either view: for every feature we leave out (simplifying lexical representations), we complicate the grammar (with the rule or principle needed to insert that feature later).

With the development of autosegmental phonology, much evidence has accumulated that not all segments are fully specified for all features at all points of a derivation. The general form of the argument is that some segments behave *as if* they are not characterized for a certain feature F with respect to a given phonological or phonetic rule. The most straightforward interpretation of this fact is to assume that the segments in question are not specified for F in underlying representation. There are three main types of cases, which I will term *dependency, transparency,* and *inertness*.

The first case, dependency, refers to situations in which the value of a feature F in alternating segments is entirely determined by contextual feature values. In such cases these segments are systematically unspecified for the alternating feature, and receive a value of this feature through autosegmental spreading. Familiar cases include tone spreading onto toneless suffixes (see Goldsmith 1976 for Igbo or Leben 1978 for Mende), and alternating affixes in vowel harmony systems, such as Akan (see Clements 1985). The second case, transparency, involves situations in which phonologically nonalternating segments are transparent to assimilatory and dissimilatory processes. These include neutral vowels in vowel harmony systems, and the non-tone-bearing units of tone systems (see the above references for examples). By treating such segments as non-P-bearing segments which are uncharacterized for the spreading feature F, we can explain why they do not block the passage of that feature, and also predict, correctly, that they are not themselves propagators of that feature. The third case, inertness, involves segments that do not initiate or undergo assimilation, but that unlike transparent segments do not allow the assimilating feature to pass through them. These can be regarded as members of the class of P-bearers which are prohibited from bearing the feature F due to a feature cooccurrence constraint holding both underlingly and in the rule's output (see Archangeli and Pulleyblank, forthcoming for a treatment of high vowels in Yoruba in these terms).

There is good evidence, then, arising from the literature in autosegmental phonology, that some features are absent in the feature characterization of some segments during phonological derivations, and it is natural and legitimate to ask whether this approach can be generalized to further cases. A number of arguments have been offered in favor of such a move, both in the past and more recently. Not all the arguments are of equal value, however, and it would be useful to sift out some of the arguments that make a less than fully convincing case.

1. *Simplification of grammars.* It has sometimes been suggested that removal of redundant features from underlying representations can be justified on grounds of formal simplicity. But while a thorough-going theory of underspecification simplifies the lexicon, it complicates the grammar due to the extra fill-in rules required. This extra complexity can be avoided only if it can be shown that such rules are universal or else independently derivable from other features of a grammar. However, this does not seem to be possible; different languages may have partly different sets of default rules which may apply at different points in a derivation, as much current research has shown.

2. *Expression of segmental redundancies.* It has also been argued that redundancy rules are needed to express generalizations about the structure of the phoneme inventory. While this is correct, it does not require that phonological representations must be incompletely specified during phonological derivations. Rather, the redundancy rules could be required to apply as a block before the phonological rules, or indeed they could be expressed as well-formedness conditions that apply to fully specified representations as filters (Stanley 1967).

3. *The Duplication Problem.* It has been observed that the earlier strata of phonological derivations tend to be "structure-preserving" in the sense that phonological rules of those strata do not create segments distinct from those found in underlying representations (see Kenstowicz and Kisseberth 1977 for discus-

sion). This could be explained on the assumption that redundancy rules apply to the output of some subset of the phonological rules, providing a characterization of the phoneme inventory at a point later than underlying representation. However this account, even if correct, does not require redundant features to be omitted in underlying representation. The redundancy rules could equally be viewed as applying pervasively across a derivation, first to underlying representations and then to the output of each phonological rule, or indeed as applying just twice, once underlyingly and once as a filter on the rules' output.

Furthermore, the skeptic might point out that a thorough-going theory of underspecification, without adequate constraints, takes a step backward in terms of the learnability problem, since it presents the language learner with the task of determining just which features are omitted underlyingly, and when they are inserted in derivations. It seems clear, then, that we need to sharpen up our criteria for determining when a feature may be absent in underlying representations, in the aim of constructing a theory that does not place an unwarranted burden on the language learner.

Following are some basic questions that a theory of less-than-full binary feature specification should be able to answer.

(1) Q1. Do all segments have binary specifications for all features in underlying representation? If not,
  i. Under what circumstances can a predictable feature be completely omitted in underlying representation?
  ii. Under what conditions can one value of a binary feature be omitted in underlying representation?
  iii. How are unspecified feature values reintroduced?
  Q2. Can phonological rules make specific reference to the absence of a feature?
  Q3. What crosslinguistic generalizations does the theory capture?

We will try to take a first step toward answering these questions in the following discussion. I will offer a brief summary of a linguistic system requiring fairly systematic underspecification of certain features, and will show how such a system can be incorporated within a theoretical account which I term "degree 2" underspecification. I will then argue in favor of such a theory on the basis of sequential constraints in English. In this discussion, I will assume the following definitions:

(2) A feature or feature value is
  a. *contrastive* if it is crucially required to distinguish at least two segments in underlying representation;
  b. *predictable* if it is possible to suppress it in underlying representation and insert it derivationally.

2. A Feature Analysis of the Barra Dialect of Gaelic

Following the primary description of Borgstrøm (1937,1940) and the subsequent analysis in Clements (1986), we may recognize the following underlying consonant inventory in the Barra dialect of Gaelic, at least to a first approximation.

Palatalized segments are marked with a prime, interpreted here as designating the feature [-back]. Notice that coronals and velars contrast for this feature while labials do not.

(3)						
	voiceless aspirated stops	p	t	t'	k	k'
	voiceless unaspirated stops	b	d	d'	g	g'
	voiceless fricatives	f	s	s'	x	x'
	voiced fricatives	v		z'	ɣ	
	lenited nasals	m	n			
	nonlenited nasals		N	N'		
	lenited liquids		r	r', l'		
	nonlenited liquids		R, L	L'		

Stressed vowels fall into three symmetrical series, front, central and back:

(4)				
	high:	i	ɨ	u
	mid:	e	ʌ	o
	low:	æ	a	ɔ

Of interest here is a rule of Palatal Assimilation, according to which nonlabial sonorants agree in palatality with a following nonlabial consonant, whether plain or palatal. The sequences attested in Borgstrøm's description are the following:

(5)		
	plain:	nd ŋg nx Nd Nx Lt Lk Lx rɣ rx rk Rk
	palatal:	ŋ'g' N'D' l't' l'k' L't' r'k' r'x'

Labials and plain nonlenited [R] are inert with respect to Palatal Assimilation, neither triggering this rule nor undergoing it.

(6) a. *palatal sonorants may occur before (plain) labials:*
plain sonorants before labials: nv rm rv rp Lv Lp
palatal sonorants before labials: N'p N'm l'm r'v
b. *(plain) [m] may occur before palatal consonants:*
[m] before plain consonants: mr mb
[m] before palatal consonants: ml' ms' mx'
c. *(plain) [R] may occur before palatal consonants:*
[R] before plain consonants: Rt RL RN
[R] before palatal consonants: Rk' Rt' RL'

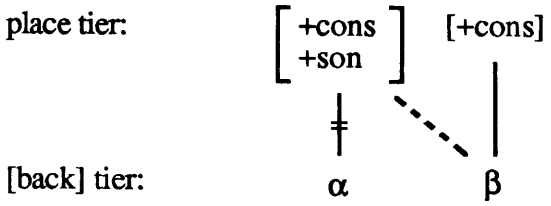
How may we explain the asymmetrical behavior displayed by the labials and [R]? Following the analysis given in Clements (1986), I will assume that the feature [back] is not specified in labials. I will also assume that it is not specified in [R], which does not have a palatal counterpart.

(7)	m	n	N	N'	r	r'	R	l'	L	L'	p	t	t'	k	k'	etc.
back:	0	-	+	-	+	-	0	-	+	-	0	+	-	+	-	

A SUBSTANTIVE THEORY OF FEATURE SPECIFICATION

The rule of Palatal Assimilation may now be stated as in (8). It spreads the backness specification of any consonant bearing one onto the preceding consonant, provided that it is also specified for some value of backness.

(8) Palatal Assimilation:



Labials and [R] can neither be targets nor triggers, given the feature analysis in (7), because they do not bear a backness specification.

Some further evidence in favor of this analysis comes from a rule of epenthesis which inserts a vowel between a sonorant and a following consonant. This vowel is realized as [ə] between [m] and a following sonorant, and otherwise is normally realized as a copy of the preceding vowel: thus underlying /aLpə/ 'Scotland' is realized as [a.Lapə]. The value for [back] in this vowel is dependent on the preceding sonorant, however, occurring as [+back] after plain sonorants and [-back] after palatal ones.

(9) i. after plain sonorants:

aLapə	'Scotland'
s'ærav	'bitter'
duNuxəɣ	'Duncan'
s'ænaxəs	'conversation'

ii. after palatal sonorants:

bul'ik'	'bellows' (gen. sg.)
sɨr'i	'wooing'
mʌr'ev	'the dead'
dɨr'i	'fishing line' (gen.sg.)

There is some evidence that the labial sonorant [m] is also transparent to this assimilation. In the few relevant examples to be found in Borgstrøm's data, the epenthetic vowel is always identical to the vowel preceding [m], whether it is front or back. In particular, if the preceding vowel is [-back], so is the following epenthetic vowel:

(10)

t'imix'aL	'round about'
æmæs'ir'	'time'

This behavior can be explained under the feature assignment given in (7). As is pointed out in Clements (1986:329), "Only the labial consonants are not paired by the correlation of palatality, and it is just after the labial consonant [m] among plain consonants that front epenthetic vowels may appear... We may explain this array of data on the basis of our earlier assumption that nonlabial consonants (coronals and velars) are distinctively specified for the features [±back], while the labials (in which backness is systematically nondistinctive) are unspecified for this feature."[1]

3. Degrees of Underspecification

Theories of feature specification can be ranged along a scale depending on the degree of underspecification they recognize. A degree-0 theory of feature specification would be one in which all features are fully specified in all segments. In practice, however, phonologists have usually recognized some amount of underspecification. Below I summarize two theories which allow some features to be absent underlyingly and inserted derivationally, and show how each would characterize a five-vowel system /iueoa/ in underlying representation, assuming the features [high,round, low,voiced].

(11) a. Degree 1: all classificatory features are fully specified in UR (cf. Stanley 1967, Chomsky and Halle 1968)

	i	u	e	o	a
high	+	+	-	-	-
round	-	+	-	+	-
low	-	-	-	-	+
voiced					

b. Degree 2: all and only contrastive features are specified in UR (cf. Halle 1959)

	i	u	e	o	a
high	+	+	-	-	
round	-	+	-	+	
low			-		+
voiced					

In degree 1 theory, all features are fully specified except for [voiced], which is not a classificatory feature of vowels, since vowels are never distinguished by this feature in underlying representation. In degree 2 theory, the features [high,round] are unspecified in the low vowel since neither of them crucially distinguishes [a] from another vowel in the system. Similarly, [low] is not specified in /i u o/ since this feature is only crucially required to distinguish /e/ and /a/. (It cannot be omitted in /e/ since then /e/ and /a/ would be nondistinct.) The following redundancy rules express the structure of the five-vowel system. In degree 1 theory, rules 1-4 apply as feature-checking rules, and in degree 2 theory they apply as feature-filling rules:

(12) Redundancy rules:

R-rule 1. [+syllabic,+low] → [-high]
R-rule 2. [+syllabic,+low] → [-round]
R-rule 3. [+syllabic,+high] → [-low]
R-rule 4. [+syllabic,+round] → [-low]
R-rule 5. [+syllabic] → [+voiced]

As we have seen, at least as much underspecification as is provided by degree 2 theory is required if we are to give a principled explanation of the Gaelic data discussed in section 3. This theory will also account correctly for the evidence from dependency, transparency and inertness discussed in section 1, involving tonal and vowel harmony phenomena: in typical cases of this type, the underspecified features are not contrastive (but see further discussion below).

A SUBSTANTIVE THEORY OF FEATURE SPECIFICATION

4. Evidence for Contrastive Features in Underlying Representation

Let us consider the more general empirical claims of degree 2 theory. One strong prediction is that all and only noncontrastive values of a feature F are underlyingly absent and thus transparent to rules of assimilation and dissimilation. An impressive range of evidence supporting such a claim, as well as some possible counterexamples, are discussed by Steriade (1987). This claim is not fully supported in the Barra dialect of Gaelic, since plain [n] and palatal [l'], which have no counterparts in the plain/palatal correlation, nevertheless behave as though they bear intrinsic specifications for [back] at the point where Vowel Copy applies to fill in features of the epenthetic vowel: cf. *bul'ik''*bellows' (gen. sg.), *s'ænaxəs* 'conversation' and similar examples. Apparently, then, some noncontrastive features may be present at a point where others are not, under conditions that remain to be determined.

Another claim of the theory is that both values of contrastive features are present underlyingly and thus should be accessible to rules and constraints applying to underlying representation, while in contrast, noncontrastive feature values should be generally inaccessible to such rules. Evidence bearing on this claim has been collected by Christdas (1986, 1988). From this point of view, a good strategy for determining the extent to which underlying representations are underspecified is to examine the rules and constraints that apply to this level.

For example, underlying segment structure constraints can be considered in this light. The vowel system of Acoma is /i ɨ u e æ / (Miller 1965). Let us assume the following (fully specified) feature description:

(13)

	i	ɨ	u	e	æ
high	+	+	+	-	-
low	-	-	-	-	+
back	-	+	+	-	-
round	-	-	+	-	-

In this system, all [+back] vowels are [+high] and all [-back] vowels are [-round]. These two generalizations are straightforwardly captured in degree 2 theory if we require that the set of redundancy rules must hold of the fully specified system. The full set of redundancy rules for Acoma vowels is stated in (15) below. Notice that these rules are true not only of the underspecified system (14) but also of (13).

(14)

	i	ɨ	u	e	æ
high	+			-	
low				-	+
back	-	+			
round		-	+		

(15) redundancy rules:

1. [+lo] → [-hi]
2. [-hi] → [-bk]
3. [+rd] → [+bk]
4. [+bk] → [+hi]
5. [-bk] → [-rd]
6. [+hi] → [-lo]
7. [+rd] → [+hi]
8. [-hi] → [-rd]

Notice that in order to obtain this result, it is crucial that all contrastive values be present at the level at which the rules are stated. In degree 2 theory (as well as degree 1 theory), this can be underlying representation. If our theory allowed contrastive values to be absent in underlying representation, these rules would not express true generalizations until all contrastive values were present; but these values would not be present until *after* the redundancy rules apply.

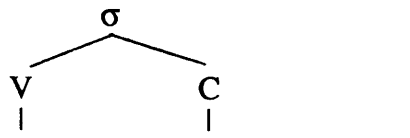
Another set of rules which apply to the level of underlying representation are the rules of core syllabification. We find evidence that English core syllabification rules crucially require mention of both values of certain contrastive features. Consider, for example, the feature [strident], which distinguishes [s] from [θ].[2] Only [s] (and marginally [š]) syllabifies with a following stop, as in *spit, stop, skip*. That it does so in the core syllabification component is shown by the stress pattern of words like *orchestra,* whose antepenultimate stress indicates that the penultimate syllable is light, as well as by the failure of aspiration in words like *despair, mosquito,* cf. *distemper, mistime* in which [s] does not resyllabify across the prefix boundary. Similarly, [s] is mentioned in the constraint (holding over roots and level 1 stems) which prohibits adjacent occurrences of segments characterized as [+strid,+cor, +cont]; this constraint rules out [sz, zs, čs, čz, šs, šš, zš, šž, čš], etc., while allowing [sč] (*eschew, pasture*) and [sθ] (*Esther, esthetic*), etc. In addition, a negative syllable structure constraint prohibits nonstrident coronals from syllabifying with a following lateral, but does not prevent strident coronals from doing so: *[dl-, tl-, θl-] but *slip, Schlesinger*. When stated formally, the first two of these constraints must mention [+strident] while the third mentions [-strident]. To be sure, an argument of this type depends in detail on our assumptions concerning the relative role of positive and negative conditions in syllabification; the claim is simply that if we hold any reasonable set of assumptions constant, a study of crosslinguistic constraints on segment sequences will show that both values of contrastive features must be mentioned if generalizations are not to be lost.[3]

Let us now consider the features [back,cont]. First, we observe that [stop+w] clusters are excluded in English before the underlying nonlow back vowels, /ɨ, ɨ, u, ʎ, ʌ, ō, o/. Accordingly we do not find stressed surface syllables of the form [Cwaw, Cwŭ, Cwyū, Cwʌ, Cwū, Cwɔ], nor unstressed syllables of the form [Cwyə], where C is a stop.[4] The prohibition of Cw before back rounded vowels is a dissimilatory constraint which is commonly encountered across languages (Kawasaki 1982).

A different constraint of English excludes short front and nonlow vowels before tautosyllabic [r]. Thus we do not find the nuclear sequences [ɪr, ĕr, ær, ŭr, ʎr], although [ăr, ŏr] are permitted as in *park, fork*. This constraint and the previous one mention opposite values of the features [back,cont], as shown in (16):

(16) a. * [-cont] w [+back,-low]

b. *



Notice that the features [back,cont] are contrastive in the segment classes concerned. Thus the feature [back] minimally contrasts /ɨ, u/, and [cont] minimally contrasts /r,l/ and /θ, t/. Under degree 2 theory, then, we expect these features to be fully specified in underlying representation. If they were not, then these constraints could not be expressed (see below for discussion of why unspecified segmental features cannot be directly referred to by rules).[5]

Sequential constraints must also be able to access both values of the features [approximant] and [continuant] in English. Consider the following constraints on sequences of the form sRVR, where R = [+sonorant,+consonant], and V = short or long vowel or diphthong:

(17) a. both Rs may not be nasals: *snVn, snVm, smVn, smVm
b. both Rs may not be identical liquids: *slVl (also *šrVr)

These constraints are not accidental gaps, since other sequences of the general form sRVR are well attested. Thus (i) nasals may combine freely with liquids: *snore, snare, snail, snell, smart, smear, smorgasbord, smell, smile;* (ii) liquids may combine freely with nasals: *slam, slander, slang, slant, slime, slink, slum, slumber, slump*; and (iii) [l] combines in a few cases with [r]: *slur, slurp*. These constraints extend fairly well to the larger class FRVR (where F = any fricative that can syllabify with R, namely [s, š, θ, f]). In this more general form they are exceptionless with short vowels (compare the well-formed *shrill, thrill, frill, floor,* with non-identical liquids), and we find just a single exception to (17b) with a long vowel (*flail*, beside the regular *flair, frail,* etc.). A few more exceptions arise (but only a few) if we extend it to the still more inclusive class ORVR (where O = obstruent): *drear, prayer, prior, briar*. It holds very well over the yet larger class sORVR: compare the total absence of *splVl, sprVr, strVr, sklVl, skrVr, beside the well-formed *scroll, stroll, sclerosis, Australia.* These constraints exclude large numbers of logically possible sequences, and express strong dissimilatory preferences in English sequential structure. They hold within roots and across level 1 stems, but do not constraint level 2 combinations (cf. *slowly, sleighless* and compounds such as *snow man*).

To summarize, English avoids CRVR sequences of two types in roots and the level 1 phonology. First, two nasals, i.e. [+son,-approx] cannot occur in the R position. Second, with the exceptions noted, two liquids, i.e. [+approx,+cons] cannot agree in their specifications for [cont] in the R position. To express these constraints, both values of [approx] and [continuant] must be present at the level at which these constraints apply. These features are, once again, contrastive in the segment classes concerned.[6]

Our conclusion is that in English, the features [strident, continuant, back, approximant] must be fully specified for both values in the segment classes in which they are contrastive in underlying representation.

5. Toward a Substantive Theory of Feature Specification

These conclusions are consistent with the view that underlying representations are incompletely specified to the extent allowed in degree 2 theory, a theory

supported by the analysis of the Barra dialect of Gaelic in Clements (1986) and above, and by the further data discussed in Steriade (1987). However, they are not consistent with some theories that would require more radical underspecification.

The general problem is the following. In many languages we find situations in which two or more constraints refer to opposite values of a binary feature. If one of these is omitted in underlying representations, we can only refer to it by explicit reference to Ø (absence of a specification). But this approach gives rise to a problem. To see this, consider the hypothetical consonant system in (18), in which only one value of each feature is specified underlyingly. The redundancy rules given in (19) will map this into a fully specified representation.

(18)

/b	m	t	d	n	k	g/	
+	+						labial
		+	+	+			coronal
					+	+	dorsal
	+			+			sonorant
			+			+	voiced

(19) redundancy rules:

R-rule 1: [+labial] → [+voiced]
R-rule 2: [+sonorant] → [+voiced]
R-rule 3: [ØF] → [-F]

In this system, natural classes are defined by the features [+labial], [+coronal], [+dorsal], [+sonorant], [+voiced] and their various intersections. If rules are allowed to refer only to specified values, then only natural classes can be referred to, as we desire. If rules can refer to Ø specifications, however, then they can refer to unnatural classes such as [Øvoiced], which would select the set /b,m,t,n,k/ in spite of the fact that it does not form a natural class. We must therefore prohibit rules from referring explicitly to Ø specifications in such a theory; but then we cannot state the full range of constraints on underlying representations.

For these reasons we cannot, apparently, recognize a higher degree of underspecification than that provided by degree 2 theory, which assumes that contrastive values of features are present underlyingly, and that noncontrastive values are inserted later by redundancy rules. However, this theory is not quite correct, and we must now consider its limitations, and attempt to determine how it must be modified.

Certain features are widely found to be underspecified even when they are contrastive. For example, Pulleyblank (1986) argues that in the three-level tone system of Yoruba, the mid tone is unspecified underlyingly, even though it contrasts minimally with both high and low. Similar demonstrations for two-level Bantu languages have been made by Kisseberth (1984, for Digo) and Leung (1986, for Llogoori). In all these languages, the unexpressed or default tone must later be inserted in order to account for tonal processes such as contour tone formation. It seems that in at least some tone languages, one value of contrastive tone features can be omitted underlyingly and inserted derivationally. That this is not true of all tone languages is shown by the case of Kikuyu, a Bantu language which requires

both of its tones to be underlyingly specified in order for tone mapping processes to be correctly expressed (Clements 1984).

Besides tone, certain segmental features that behave in a prosodic fashion can apparently be underspecified even when contrastive. For example, in Turkish, velars and laterals occur in contrastive plain and palatal (i.e. [±back]) forms in underlying representation. However, only the feature [-back] is specified underlyingly, since plain consonants (unlike the palatal ones) are transparent to backness harmony. This case is problematical for a pure version of degree 2 theory since [back] is clearly a two-valued feature: for example, some segments are inherently [+back] and block the propagation of backness harmony, unlike segments that are simply unspecified for this feature (see Clements and Sezer 1982 for further discussion).

Similarly, emphasis in Arabic is usually treated in terms of a prosodically represented feature [+E] (involving pharyngealization) which spreads across the syllable, subject to segmental blocking effects; although this feature is contrastive, spreading can be most straightforwardly expressed if the emphasis feature is one-valued at the point where spreading applies. As in the case of Turkish, there is evidence that emphasis is a two-valued feature, since some inherently nonemphatic segments block the transmission of emphasis (see the analysis in Card 1983).

These remarks lead us to a position that we might term "degree 2+" theory. First, just as in degree 2 theory, noncontrastive values are not normally present in underlying representation. As a result, constraints on underlying representation cannot access these values. This predicts, correctly, that we do not find constraints on underlying segment sequences in English referring to such features as [spread glottis] or [tense]; these noncontrastive features are introduced only derivationally, presumably at the point when they are first referred to by a rule. We must make an exception, however, for noncontrastive values of features that function prosodically, i.e. which commute over a domain larger than the segment, such as the morpheme or word. In many such systems, we find that noncontrastive values function opaquely to block the spread of the prosodic feature (see e.g. Clements 1985 for discussion of Akan). And in the limit case, we must allow that a feature can "function prosodically" if it engages in assimilatory spreading, since as we observed earlier, the feature [back] is specified in certain Barra Gaelic segments ([n,l']) in which it is not distinctive.

Secondly, contrastive values are normally fully specified in the segment classes in which they are contrastive, but need not be when they function prosodically. In the latter case, we may assume that only one value is present in the default case, and that a two-valued analysis is adopted only in the presence of sufficient evidence, such as the presence of constraints on underlying representation referring to both values. Otherwise, contrastive values are fully specified in the default case. We must allow for cases of "marked" underspecification, however, in the face of evidence provided by Itô and Mester (1986) that the contrastive feature [voiced] has only one value underlyingly in Japanese. We further allow that some features, such as the articulator features [labial, coronal, dorsal] proposed by Sagey (1986), are one-valued both underlyingly and on the surface. These features are of course normally contrastive, but do not require two-valued specification, simply because they are inherently one-valued.

The theory outlined above can be summarized as follows:

(20) *Degree-2+ Feature Specification:*

a. Noncontrastive values of prosodically functioning features (those whose domain is larger than the segment) may be specified in underlying representation, in the marked case;
b. Otherwise, noncontrastive values are not specified in underlying representation;
c. Contrastive values of prosodically functioning features are underlyingly one-valued, in the unmarked case;
d. Otherwise, contrastive values are two-valued in the segment classes in which they are contrastive, in the unmarked case;
e. Articulator features are always one-valued.

Given such a theory, the hypothetical segment inventory in (18) will be represented as follows, in the unmarked case (assuming that no features function prosodically):

(21)

/b	m	t	d	n	k	g/	
+	+						labial
		+	+	+			coronal
					+	+	dorsal
-	+	-	-	+	-	-	sonorant
		-	+		-	+	voiced

I assume that the major class features [sonorant,approximant,consonantal] are always contrastive and never function prosodically, and are therefore always fully specified in underlying representation.[7] It will be noticed that under this proposal, Ø cannot function as a third value, since [ØF] never stands in minimal opposition to [+F] or [-F]: a segment bearing [ØF] will always be distinguished from segments bearing [+F] or [-F] by some other features as well. This is true everywhere except in the case of "prosodically functioning" features, where a Ø specification can contrast with both plus and minus specifications, in the default case. But this is not problematical, since this is just the correct result. For example, there are tone languages in which toneless morphemes contrast with both H and L tone morphemes, and phonological rules must be able to refer to the property of being toneless (Pulleyblank 1986, Leung 1986).

I conclude with a provisional attempt to answer the questions stated at the outset.

Q1. *Do all segments have binary specifications for all features in underlying representation?* No. (1a) Predictable features can be completely omitted in underlying representations just if they are not contrastive in any segment. (1b) One value of a binary feature can be omitted in underlying representation just under the conditions stated in (20). (1c) Unspecified features are reintroduced derivationally by redundancy rules at the point at which they are first referred to by a phonological rule.

Q2. *Can phonological rules make reference to the absence of a feature?* No: they cannot refer explicitly to Ø, except in the case of prosodically functioning features such as tone.

Q3. *What crosslinguistic generalizations does the theory capture?* This theory expresses the fact that the phenomena of dependency, transparency and inertness normally involve either noncontrastive values, or contrastive values of prosodically functioning features. It also predicts that constraints and rules applying to underlying representation may make reference to both values of contrastive features, but do not make reference to noncontrastive features, except (in the marked case) when they function prosodically.

Notes

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1. The behavior of [R] is consistent with this analysis, in the sense that the epenthetic vowel is always identical to the preceding vowel. However, we cannot show that [R] is crucially unspecified for [back] with respect to this rule, since no cases are attested in Borgstrøm's data in which the preceding vowel is [-back].

2. If it is assumed that some other feature distinguishes [s] from [θ], the same argument will apply, *mutatis mutandis*.

3. For the analysis of [s] given above I assume the theory of negative and postive syllable structure conditions given in Clements and Keyser (1983).

4. Some speakers appear to permit the underlying sequence /kwŏr/, giving surface [kwɔr] as in *quarrel, quarry, quart, quarter, quartet, quartz*. As [a] does not occur in the context [kw_r] for these speakers, we may derive this [ɔ] from underlying /a/. The feature analysis of English vowels assumed here is that of Halle and Mohanan (1985); note that regardless of what feature system we use, [Cw] must be excluded before nonlow back vowels, which is the point of concern here.

5. There is some evidence that short front and low vowels may occur underlyingly in English, presented by alternations such as *Homer/Homeric, Milton/Miltonian, dear/dearth, year/yearling*. If this is correct, (16b) should be understood as the structural description of a rule turning the sequence in question into syllabic [r]. The argument still holds, however, since this rule is not crucially ordered after any other segmental rule, and thus accesses underlying segmental feature representations directly.

6. I assume that nasals and liquids are minimally distinguished in underlying representation by the feature [approximant], and rhotic and lateral liquids by the feature [continuant], for reasons presented in Clements (in press). In more traditional approaches, the feature [nasal] would be used to distinguish nasals and liquids, allowing the same argument to be made, however.

7. Christdas (1988) proposes that these and other "primary features" are always fully specified, regardless of whether they serve a crucially contrastive function or not.

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